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## BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/856,209
Filing Date: May 18, 2001
Appellant(s): NAKAMURA ET AL.

Gerald Shekleton
For Appellant

## EXAMINER'S ANSWER



This is in response to the appeal brief filed 6/6/2005.

### *(1) Real Party in Interest*

A statement identifying the real party in interest is contained in the brief.

*(2) Related Appeals and Interferences*

A statement identifying the related appeals and interferences, which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

*(3) Status of Claims*

The statement of the status of the claims contained in the brief is correct.

*(4) Status of Amendments After Final*

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

*(5) Summary of Invention*

The summary of invention contained in the brief is correct.

*(6) Grounds of Rejection to be Reviewed on Appeal*

The appellant's statement of the grounds of rejection (the issues) in the brief is correct.

*(7) Claims Appendix*

The copy of the appealed claims contained in the Appendix to the brief is correct.

*(8) Evidence Relied Upon*

The following is a listing of evidence relied upon in the rejection of claims under appeal.

| | | |
|---|---|---|
| 5,968,264 | Iida et al | 10-1999 |

*(9) Grounds of Rejection*

The following ground(s) of rejection are applicable to the appealed claims:

1. Claims 17-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264).

In a method of manufacturing a crystal ingot, note entire reference, Iida teaches a silicon single crystal grown through the use of a crystal pulling apparatus, where wafers were sliced from the thus-obtained silicon ingot (col 14, ln 20-67). Iida also teaches (Delta $G=G_e-G_c$) is not greater than 5°C/cm, where $G_e$ is a temperature gradient at the periphery and $G_c$ is a temperature gradient at the center portion of a growing crystal (col 10, ln 5-15). Iida also teaches a $G_c$=30°C/cm (3.0 °C/mm) and a $G_e$=35°C/cm (3.5 °C/mm)(Fig 8), where the $G_e/G_c$ ratio can be determined to be 1.16. Iida also discloses that wafers were sliced from the thus-obtained silicon ingot (col 14, ln 20-67) Iida also teaches an OSF region is observed between a N region, a neutral region having few defects, and a vacancy rich region and interstitial rich region (col 15, ln 1-15 and Fig 10A). Iida also teaches the $G_c$ is the temperature gradient at a central portion of the growing crystal both in an in-crystal descending zone, 1300-100°C, or in the vicinity of the solid-liquid interface of the crystal, melting point of silicon to 1400°C (col 4, ln 5-15 and col 4, ln 35-39. Iida also teaches an OSF ring with an inner diameter of at least ½ a wafer inner diameter (Fig 10A) at a pulling speed of 0.62 mm/min. Iida et al also discloses $G_e$ is the temperature gradient at a peripheral portion of the crystal and $G_c$ is a temperature gradient at a central portion, where both are in an in-crystal descending temperature zone between 1420°C and 1350°C or between a melting point of silicon and 1400°C in the vicinity of the solid-liquid interface (col 10, ln 1-15), this reads on applicants' temperature region from the solid-liquid interface temperature to approximately 1350°C.

Iida et al does not teach the upper bound of $1.06x(G1_{edge} \text{ x } G2_{center})^{-0.2}$. Iida et al does teach varying the pulling rate between 1.0-0.4 mm/min during growth of a silicon ingot and slicing wafers from the thus obtain ingot (Example 1 and Example 2). Iida et al also shows the OSF ring diameter changes with pulling rate, such that the ratio of OSF ring diameter to crystal diameter is greater than 0.5, note Figure 10A. The range of OSF diameters taught by Iida et al inherently overlaps the range claimed because the upper bound is greater than 0.5 and Iida et al discloses ratios of OSF ring diameter to crystal diameter from 0.5 to about 1. Overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claim 17, Iida et al is silent to the GOIC of the silicon ingot. However, Iida et al teaches a method of producing a silicon ingot comprising a similar process of pulling the ingot, as applicant. Therefore, the ingot inherently will have a GOIC with the claimed range because a similar process is expected to produce a product with similar properties.

***(10) Response to Argument***

Appellant's argument that Iida et al does not teach the upper bound of $1.06x(G1_{edge}xG2_{center})^{-0.2}$ and the Examiner ignores the parameter $G2_{center}$ is noted but is not found persuasive. The Examiner maintains that the method taught by Iida et al to determine the optimal pulling speed for a $\Delta G$ of less than 5°C/cm is to vary the pulling speed of an ingot from a relatively slow pulling rate (0.4 mm/min) to a relatively fast pulling rate (1.0 mm/min). The Examiner also maintains that the diameter of the OSF ring is dependent on the pulling speed, which is taught by Iida et al in Fig 10A and 10B and which is also conventionally known in the art; therefore by increasing the pulling speed, the OSF ring diameter will increase, as shown in

cross sectional view of Fig 10A and 10B. By changing the pulling speed, as suggested by Iida et al, an ingot will necessarily be formed with an OSF ring diameter within the claimed range of greater than 0.5 and less than $1.06x(G1_{center}xG2_{center})^{-0.2}$ because the OSF ring gradually changes from 0-1. Although, Iida et al does not teach the claimed upper bound, the ingot formed by varying pulling rate will necessarily have a portion within the claimed range for the OSF ring. Evidence showing the critically or a persuasive argument that the upper bound of the range produces unexpected results has not been provided. The ingot suggested by Iida et al will contain a portion, which will necessarily overlap the claimed range, and overlapping ranges are held to be obvious (MPEP 2144.05).

Appellant's argument that Figures 10A and 10B of Iida et al cannot lead one to the invention of claim 17 is noted but is not found persuasive. Figures 10A and 10B of Iida et al are relied upon to show the conventionally known trend that OSF ring diameter changes with pulling rate. A silicon single crystal pulled at a Gc=30°C/cm and Ge=35°C/cm, as taught by Iida et al in Figure 8, which is subjected to the method of varying pulling rates to determine the optimal pulling rate will produce similar increases in OSF diameter as illustrated in Figure 10A. The Examiner is not suggesting the same exact profile will be produced for Gc=30°C/cm and Ge=35°C/cm, merely that a similar profile will be formed and the profile will necessarily have a region which will have an OSF ring in the claimed region of greater than 0.5 and less than $1.06x(G1_{center}xG2_{center})^{-0.2}$.

Appellant's argument that Iida et al does not teach a GOI C Mode yield of 60% or higher is noted but is not found persuasive. The instant claims merely require producing a silicon single crystal ingot having 60% or more GOI C mode yield. The Examiner maintains that Iida et al

teaches using a temperature gradient difference of less than 5°C/cm and specifically teaches Gc=30°C/cm and Ge=35°C/cm in Figure 8. Iida et al also teaches varying pulling rate, which will necessarily form an ingot with at least a portion of which will have an OSF ring to crystal diameter ratio within the claimed. Therefore, the portion of the ingot suggested by Iida et al will be expected to have similar properties, namely GOI C value, to the ingot claimed by applicant because similar processing conditions are expected to produce similar results.

Appellant's argument that Figure 8 teaches ΔG units measure in time and not distance is noted but is not found persuasive (pg 5). Figure 8 of Iida et al does teach $\Delta G \leq 5$(°C/min), however the Examiner believes this to be a mistyped value. The temperature gradient along the horizontal axis of Fig 8 clearly shows the unit of temperature gradient as °C/cm. Also, throughout the specification, temperature gradient is measure in units of °C/cm, note column 14, ln 40-45, and claim 6. The units for temperature gradient are clearly taught by Iida et al to be °C/min, note column 10, ln 1-15, and the °C/min in Figure 8 is clearly a mistake.

Appellant's argument that claim is patentable because the two claimed parameters are not taught or made obvious by Iida et al is noted but is not found persuasive. Appellant's allege Iida et al does not teach $1.15 \leq G1_{edge}/G1_{center} \leq 1.25$. The Examiner admits Iida et al does not explicitly teach the claimed range, however the Examiner maintains that Iida et al discloses in Fig 8 a $G_{edge}$ of 35°C/cm and a $G_{center}$ of 30°C/cm, at a growth rate of 0.3 mm/min and the ratio of $G_{edge}/G_{center}$ can be determined to be approximately 1.166. Therefore, since a specific example is disclosed by Iida et al which is within the claimed range, the range is anticipated, note MPEP 2131.03 [R-2] I. Appellant's also alleges that the prior art does not teach $G2_{center}$; therefore is unobvious in view of Iida. The Examiner admits $G2_{center}$ is not explicitly taught by Iida et al, however the Examiner

maintains that the $G2_{center}$ parameter is merely used to specify an upper bound. Iida et al teaches varying the pulling rate during growth to determine the optimal pulling rate and varying the pulling rate results in the OSF ring diameter to change, faster pull yields a larger ring, note Fig 10A and column 14, line 20 to column 15, line 15. At least a portion of a crystal pulled by varying pulling rate will produce an OSF ring within the claimed range because the upper bound must be greater than 0.5 and Iida clearly show a ring will be formed with a diameter ratio less than 0.5 to 1.

In conclusion, Iida et al discloses forming a silicon single crystal by controlling the temperature gradient at the center and the edge of the growing crystal to be less than 5°C/cm, specifically $G_{edge}$ of 35°C/cm and a $G_{center}$ of 30°C/cm, at a growth rate of 0.3 mm/min in Figure 8. The ratio of $G_{edge}/G_{center}$ can be determined to be approximately 1.166, which anticipates the claimed range of $1.15 \leq G1_{edge}/G2_{center} \leq 1.25$. Iida et al also teaches varying pulling rate to determine the optimal pulling rate and OSF ring diameter changes with changes in pulling rate, note Fig 10A and column 14, line 20 to column 15, line 15. Iida et al does not teach using this procedure with $G_{edge}$ of 35°C/cm and a $G_{center}$ of 30°C/cm, however a person of ordinary skill in the art would have found it obvious to vary the pulling rate to determine the optimal value for $G_{edge}$ of 35°C/cm and a $G_{center}$ of 30°C/cm, which necessarily would have formed a ingot with an OSF ring with a diameter within the claimed range. Also, the portion of the ingot within the claimed OSF ring would also be expected to have similar properties, namely GOI C value, to the crystal claimed by applicant.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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August 19, 2005

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